Project proposal Master Degree Project

Project Title: Bluetooth Low Energy in the Contiki OS

Author

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Organization and Supervisor

The thesis will be done at Swedish ICT SICS at Isafjordsgatan 22, Kista.

My supervisors will be Zhitao He and Shahid Raza of SICS.
My examiner will be Christian Schulte at KTH.

Keywords

nRF52832, BLE, Contiki, 6LoWPAN, Embedded Systems, IoT, SoC

Background

Bluetooth low energy (BLE) has since its inclusion in Bluetooth v4.0 standard emerged as a contender for weaving sensors and other devices into the fast developing Internet of Things. Using low power IP features is an essential part of an efficient IoT. The BLE and 6LoWPAN provide such features and have been emerging in technologies.

Contiki is a tiny, low-power, operating system with built in support for the 6LoWPAN standard and other networking protocols.

Problem

What interactions are made between the BLE firmware library and application processes and how can these interactions be used to identify bottlenecks and improve OS functionality?

Purpose

In order to further develop IoT using devices powered by low energy the BLE should be investigated as a contender against similar technologies.

Goal(s)

Goals are mandatory unless specified otherwise.

- Implementation of the Contiki core on the nRF52832 including real-time and event -timers and digital and serial input/output,
- Implementation of a standard BLE application profile
- (Optional) Performance and power efficiency optimizations

- (Optional) Implementation of a custom BLE application which handles analogue input
- (optional) IPv6/6LoWPAN support

Tasks

All the tasks are mandatory unless specified otherwise. The tasks are sorted in descending order of priority.

- Port a set of Contiki core system services and drivers to the platform
    - A clock source driver, that generates periodic timer interrupts from the Cortex-M4 HW timers
    - Digital output driver for LEDs
    - Digital input driver for push buttons
    - Contiki event timers, optionally reusing the tick-less event-timer from the previous thesis [1]
    - Serial output driver for printf()
    - Serial input driver for the Contiki serial-line system service
    - Contiki real-time timers
    - (Optional) 6LoWPAN
- Use the GATT API of the SDK to implement a standard BLE application profile
- Evaluate the application implementation using the Nordic nRF Toolbox app for smartphones and
- (Optional) Compare BLE and 6LoWPAN using the toolbox
- (Optional) Port the ADC driver for analog sensors from the Contiki core services
- (Optional) Build a standalone sensing application with the BLE stack disabled
- (Optional) Use an analogue Arduino Uno sensor shield to provide the input signal
- (Optional) Performance and power efficiency optimizations of the Contiki port using the nRF52 SDK's System on Chip library API

Method

The literature study of previous work [1] will create the basis for the Contiki port. The port will be done incrementally with one service (listed in section tasks) implemented at a time.

Performance optimization will be measured on speed of transmission and memory footprint.

Milestone chart (time schedule)

Starting in January 2016

Week 1 – 3	Literature study
Week 4 – 5	Toolchain setup
Week 6 – 9	Building Contiki core
Week 10 – 13	BLE application
Week 14 – 17	Optimizations

Week 18 – 20 Project report
The time schedule is subject to change according to the project needs. The project report will most likely start and gain momentum during optimization.

Risks, Consequences and Ethics

Implementing network protocols on a new operating system opens for security risks in the network and potential intrusions or disruptions in service. The Contiki software has since version 3.0 AES128 link-layer encryption which adds additional security.
Developing IoT to use less power is important because of the current energy crisis in the world [2].

Summary

The project will consist of a literature study of The Contiki operating system, the Bluetooth low energy standard and the nRF52832 system on chip. The Contiki system will be implemented on the nRF52832 with the Bluetooth stack on top.
The work will be done at SICS over the course of 20 weeks from January 2016 to June 2016.

References

[1] P.R. Narendra. Comparison of link layer of BLE and 802.15.4 - Running on Contiki OS. Master's thesis, KTH Royal Institute of Technology, Stockholm, Sweden, September 2014.
[2] Global Economic Symposium, Proposal - The Energy Crisis and Climate Change, http://www.global-economic-symposium.org/knowledgebase/the-global-environment/the-energy-crisis-and-climate-change/proposals/the-energy-crisis-and-climate-change fetched on 2015-12-30